HORMONES AND CYCLES: A REVIEW

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The basic causes of cycles in the abundance of hares, voles, grouse and other northern animals are still but little understood. Disease, predators, and parasites have all been suspected, but these are now generally believed to be, if involved at all, no more than contributing factors. Starvation is not likely to be a cause of cycles, except in the case of certain predators which may have secondary cycles reflecting fluctuations in the numbers of their prey. Efforts to show that cycles are caused by sun spot fluctuations have not met with success.

Some years ago Green and Larson (1938) found that at the time of cyclic die-off in the Varying Hare, *Lepus americanus*, in Minnesota, large numbers of these animals perished suddenly of hypoglycemic shock. This "shock disease" involves no pathogenic organism, but has as its immediate organic cause a failure of the liver to store glycogen. Any mild stress, e.g., exercise or capture, may induce convulsions and death in hares at such periods. The significance of these facts became more evident in the light of Selye's (1950) later research on the effects of stresses upon laboratory animals. His findings have been summarized by White (1950: 394) as follows: " . . . all living organisms can respond to stress as such, and . . . in this respect, the basic reaction pattern is always the same, irrespective of the agent used to produce stress. He (Selye) has called this response the General-Adaptation-Syndrome, and its derailments the Diseases of Adaptation." Physiologically, this adaptive response involves the secretion of the adrenocorticotrophic hormone (ACTH) by the pituitary and of the cortisone hormone by the adrenal cortex. Probably other hormones are involved as well, for example, one of the spleen now being investigated at the marine biological station at Naples, a hormone which, it is thought, may be responsible for the phenomenon of "second wind" in man (Crammer, 1950: 361).

Selye pointed out that the shock disease of hares resembled what he called the "diseases of adaptation", but it remained for Christian (1950) to emphasize that Selye had provided what would seem to be a satisfactory explanation of the sudden decimations that occur in cyclic species. Christian visualizes the process as follows (p. 253): "Exhaustion of the adreno-pituitary system resulting from increased stresses inherent in a high population, especially in winter, plus the late winter demands of the reproductive system, due to increased light or other factors, precipitates population-wide death with the symptoms of adrenal insufficiency and hypoglycemic convulsions."

Are birds subject to shock disease? So far as I know, it has not been reported, though the "autumn madness" of Ruffed Grouse, *Bonasa umbellus*, might be correlated with such disturbances. Most investigations of the cycles of this bird have tended to show that the periodic decreases result from heavy mortality of chicks (Bump, Darrow, *et al.*, 1947). This might mean only that in grouse, apparently unlike hares or voles, shock disease occurs among immatures rather than adults. A recent experiment conducted by the New York State Conservation Department (Anon., 1950) did precipitate a "population crash" in Ruffed Grouse and Varying Hares during the winter. The experiment was conducted on Valcour Island (area about 1000 acres) in Lake Champlain. Predators were intensively controlled on this island for a period of five years. Both grouse and hares increased rapidly, but in the winter following the third year there was a drastic decrease in both species. This was attributed, though apparently without much evidence, to disease. Populations on a control area on the mainland remained almost stable. It seems entirely possible that the crash in the two species followed collapse of hormonal defense against multiple stresses following over-population. Most investigators

have found that cyclic decreases in grouse populations are correlated with population density.

In the paper mentioned above, Christian assumes that in species not known to be cyclic, e.g., the Beaver, *Castor canadensis*, the population is held below the critical level by other factors, such as predation by man. It seems possible, however, that collapse of the adreno-pituitary system, with resulting shock disease, in voles and hares is in itself an adaptation to reduce the population of these prolific, short-lived species drastically at times of over-abundance, so that the stresses on the remaining nucleus of breeding stock are quickly alleviated. Wolves and other carnivores, on the other hand, are so very resistant to cold, semi-starvation and other privations that they may never be subject to sudden hormonal deficiencies caused by stress. In man himself, adreno-pituitary exhaustion is often a physiological symptom of schizophrenia resulting from stress—a condition not necessarily fatal (White, *op. cit.*). An even more gradual impairment of the hormonal defense mechanism is implied in the suggestion that the greater average longevity of women as compared with men reflects a "better-damped reaction to stress" (Comfort, 1950).

Investigation of the role played by hormonal deficiencies in population fluctuations among birds will require both field and laboratory studies. The hormones involved in the physiological adjustment of the mammal to stress are proving of great significance in medicine and biology. Does a similar physiological mechanism exist in birds?

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THE DINGELL-JOHNSON ACT: WILL IT BENEFIT BIRD-LIFE?

An eleven-year fight was won on August 9, 1950, with the passage of the Dingell-Johnson Bill (Public Law 681, 81st Congress, 2nd Session). This Act, which will become effective July 1, 1951, will do for fisheries conservation what the Pittman-Robertson Act has done for wild game. Together, these two pieces of legislation will advance all fields of conservation, benefiting bird-life indirectly.

The Dingell-Johnson Act authorizes the appropriation of such moneys as may be collected